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Continuing Data as Claimed by Applicant

Foreign Applications

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**** SMALL ENTITY ****

Title

Double-sided digital optical disk and method and apparatus for making

Preliminary Class

369

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DOUBLE-SIDED DIGITAL OPTICAL DISK AND METHOD AND APPARATUS FOR MAKING

Cross-reference is made to U.S. Patent Application No. 09/315,398, filed May 20, 1999, entitled "Removable Optical Storage Device and System," U.S. Provisional Application No. 60/140,633, filed June 23, 1999, entitled "Combination Mastered and Writeable Medium and Use in Electronic Book Internet Appliance," U.S. Patent Application No. 09/393,899, filed September 10, 1999, entitled "Content Distribution Method and Apparatus," U.S. Patent Application No. 09/393,150, filed September 10, 1999, entitled "Writeable Medium Access Control Using a Medium Writeable Area," U.S. Patent Application No. 09/457,104 filed December 7, 1999, entitled "Low Profile Optical Head," U.S. Patent Application Attorney File No. 4154-8 entitled "Miniature Optical Disk for Data Storage," and U.S. Patent Application Attorney File No. 4154-11 entitled "Tilt Focus Method and Mechanism for an Optical Drive," all of which are incorporated herein by reference.

The present invention is directed to a disk having optically readable digital information on both sides and in particular to a disk in which at least some optically readable marks are embossed, or otherwise provided, substantially simultaneously on both sides.

BACKGROUND INFORMATION

A number of technologies have been developed or proposed for storing optically readable information on a rotatable disk. Recent efforts have concentrated on devices in which digital (non-analog) information is stored on a disk having a diameter of about 120mm, such as a "compact disk" (CD) or a "digital versatile disk" (DVD). A number of forms of such disks have been proposed. For example, some DVD-style disks include two information layers. In some approaches, a read beam always (initially) impinges the same side of the disk (e.g., being focused on either the upper data layer or lower data layer). In other approaches that have been proposed, the read beam initially impinges a first side when a first data layer is read and initially impinges the second side when the second data layer is to be read.

With respect to optical media types, one classification relates to their read and/or write capabilities or functions relative to information content portions of the medium. The information content portions can be generally characterized as that part of the optical medium that information is read from and/or written to. The information content portions are often, but need not be, a composite film layer comprised of two or more layers of thin films on which information is recorded (written) and/or from which information is obtained (read). According to this, optical media, or any portion thereof, can be classified as: read-only, write-once, and rewriteable. A read-only optical medium refers to a medium in which data or other information is only read from the optical medium under control of the consumer or user thereof. There is no writing or recording by the user, after the read-only optical medium has been produced or manufactured. The write-once optical medium, or any portion thereof, refers to a medium or portion thereof in which the consumer or user is able to control the recording or writing information only once on the optical medium or portion thereof. After the write-once optical medium or portion thereof has information recorded thereon by the user, the write-once optical medium is not to be written to again. That is, if a portion of the medium has been written to in which a mark is provided thereon, that portion cannot be written to again, although any other portion that does not have a mark, could be written to. In one embodiment, at least the information content portions of the write-once optical medium can have an amorphous structure or state before recording. As part of the recording operation, the amorphous structure of the information content portions is transformed into a crystalline structure having the stored information. In one embodiment, the information layer of the write-once optical medium could also be comprised of dye-based or, alternatively, ablative materials. The rewriteable optical medium refers to a medium in which the information content portions may have information recorded thereon many times; in some cases, essentially without limit where the medium can be erased or over-written a substantial number of cycles and, in other cases, there is a finite limit where phase transition materials constitute the material structure of the medium.

With respect to a read-only optical medium, the read-only information can be provided thereon by injection molding, which results in pits or bumps being recorded as the information content portions. These indicia are indicative of recorded data or other information. Although

injection molding may be preferred, it is only one form of creating bumps or pits (generically referred to herein as embossing). With respect to writeable (write-once, and, rewriteable) optical media, grooves are typically formed in their substrates. The grooves are utilized in locating proper positions for information to be recorded. Such information is typically recorded in the form of marks and spaces, which are indicative of binary information. The marks and spaces are distinguished from each other by their different reflectivities and/or optical phase.

In accordance with known and prior art practice, each of the above-defined optical media can be further characterized as being second-surface media. In accordance with one definition, second-surface optical media can be defined in terms of the read operation that is conducted when reading information from the media. In particular, a second-surface optical medium can refer to a medium in which the read beam is incident on the substrate of the optical medium or disk before it is incident on the information layer.

Such second-surface (or other non-first-surface disks), while of commercial use, at least in the context of present commercial readers, are associated with certain technical issues or disadvantages including potential for energy loss in the substrate, beam distortion (such as that associated with beam tilt, coma, and the like) and, effectively, relatively large mark sizes (which affects data densities).

The relatively thick and transparent substrate of second-surface optical media makes read-only or read-write operations relatively insensitive to dust particles, scratches and the like which are located more than 50 wavelengths from the information layer. On the other hand, the second-surface optical medium can be relatively sensitive to various opto-mechanical variations. For example, common opto-mechanical variations include: (1) tilt of the substrate relative to the optical axis; (2) substrate thickness variations; and/or (3) substrate birefringence.

These variations give rise to optical aberrations which degrade system performance arising from the presence of the thick transparent layer and which can, at least theoretically, be partially compensated for by using a suitable optical path design. Such an optical path typically can only provide compensation for a single, pre-defined thickness of the layer. Because there are likely to be variations in the thickness or other properties of the transparent layer, such compensation may be less than desired at some locations of the medium.

Because the transparent layer is typically formed from a non-conduotive material, there is a further risk that rotation or similar movement of the medium will create sufficient static electrical charge that dust particles or other debris may be attracted to and may adhere to the operational surface of the medium.

Another drawback associated with second-surface optical media is that the optical requirements of such media are substantially inconsistent with the miniaturization of the disk drive and optical components for such media. As will be appreciated, a longer working distance (distance between the objective lens and the information content portions) is required for an optical system that will read information from or write information onto second-surface media. This is due to the relatively thick transparent layer through which the radiation must pass to access the recording layer. To provide the longer working distance, larger optical components (e.g., objective lens) are required. Accordingly, it would be useful to provide a digital optical disk having more than one data layer which can avoid some or all of the issues associated with non-first surface data layers.

A major contributor to on-track error rates in optical disk drive reading and writing is the improper positioning of the optical head relative to track location on the rotating disk. A "track" is a portion of the spiral or concentric data track of a typical optical disk which follows the spiral or circle for one rotation of the disk. For example, misalignment of the objective lens relative to the center of the track can cause the optical head to read information from and/or write information onto adjacent tracks and attempt to read in inter-track regions. The resulting noise can reduce the signal-to-noise ratio, leading to increased error rates. This can be caused by non-concentricity of the radial tracks on the disk relative to a reference or a point on the disk drive, such as an axis of disk rotation. Non-concentricity or runout can result from the disk and/or tracks being positioned off-center in the disk drive and/or improper vertical alignment of the plane of the disk relative to the disk drive. Non-concentricity can be viewed as potentially arising from a number of sources, each contributing toward a "budget" of maximum tolerable non-concentricity. Among the sources, contributing to the budget in previous laminated disk approaches, are the non-concentricity in the data layer of each half-disk (created during molding processes) with respect to the center of the central hole of the disk (which at least partially defines